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The new Irish Building Regulations Part L: the impact on city centre developments

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Abstract

An update of the Building Regulations Technical Guidance Document Part L has been announced by the Department of Housing for the end of 2017. This update introduces the requirements for Nearly Zero Energy Buildings (NZEB) for buildings other than dwellings and embraces a minimum renewable energy contribution. This paper is based on the draft Part L 2017 and explores the potential impact the update has on current building design strategies, using a Dublin city centre office building as an example. The paper outlines the simulation procedures using a currently-available software program and compares the building design strategies for compliance with Part L 2008 to the requirements for compliance with draft Part L 2017.

Keywords

Part L 2017, Nearly Zero Energy Buildings, NZEB, Renewable Energies, Energy and Carbon Performance.

1. Introduction

The Department of Housing, Planning, Community and Local Government has released a draft new Building Regulations Part L – Buildings other than dwellings^[1]. The draft document was out for public consultation until 2 June 2017 and is expected to come into force by the end of 2018^[2]. The draft Building Regulation reflects requirements introduced by the Energy Performance of Buildings Directive (EPBD) at EU level. Article 2(2) of Directive 2010/31/EU introduces the requirements of nearly zero energy buildings (NZEB), which are defined as “...a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced onsite or nearby”^[3].

In addition to the draft Part L release, the Department of Housing, Planning, Community and Local Government has published an “Interim NZEB Performance Specification for new buildings owned and occupied by Public Authorities.” This document applies to new buildings that are owned and occupied by public authorities and should have been used in the design of all new buildings from 1 January 2017^[4].

The Part L 2017 regulations apply to works that take place on or after 1 January 2019. A transitional agreement is noted in the Draft Part L that allows the use of Part L 2008 for projects where planning approval is applied for on or before 31 December 2018 and substantial work is completed by 1 January 2020^[1].

In addition to the Draft Part L Regulations, the Sustainable Energy Authority Ireland (SEAI) has issued an Interim NZEB Performance Specification Calculation Methodology and Excel tool used for the analysis in this report^{[5],[6]}.

This technical report takes a critical look at the impacts of the new regulations, using an existing building as an example. The example project and building name is not mentioned due to confidentiality. The building is located in Dublin city centre and will be owned and occupied by a public authority. Planning permission for this building was granted in 2016 under the Building Regulations TGD Part L – Buildings Other than Dwellings, 2008. As construction has not commenced, it is most likely that the building will fall under the new NZEB requirements.

The report gives an overview of the new Part L/NZEB requirements and analyses the design changes needed to meet the new regulations. These changes include the new Energy Performance Coefficient (EPC) and Carbon Performance Coefficient (CPC), as well as the Renewable Energy Ratio (RER). For the RER, each compliant renewable option will be analysed and assessed for its practicality.

Based on the example building, the report will review the impact of the new Part L/NZEB regulations on the current design process and design strategies, and will outline the challenges project teams will face to comply with the new requirements.

2. Overview of the Interim NZEB Performance Specification

The NZEB specification strives to improve building energy performance by 50% to 60% compared to current requirements^[2]. In addition to this, a minimum renewable energy target of 10% has been set. The improvements are explained in more detail in the next paragraph.

2.1 Simulation procedure

The energy performance of a building is analysed through the Non-domestic Energy Assessment Procedure (NEAP) using the iSBEM software provided by the SEAI.

NEAP is used to assess the Part L requirements by comparing the energy consumption of an actual building to a reference building.

The Part L/NZEB requirements will be simulated using the existing iSBEM v3.5b software and an RER calculation tool issued by the SEAI in Q1 2017.

As outlined in the NZEB Performance Specification, to simulate the Part L/NZEB requirements with the existing iSBEM software, the user has to follow the steps outlined below:

1. Manually create a reference building using Interim Public Sector Specification;
2. Simulate the performance of the actual building using the actual specification;
3. Compare the primary energy use and carbon dioxide emissions of the reference and the actual building. These will result in an Energy Performance Coefficient (EPC) and a Carbon Performance Coefficient (CPC).

$$EPC = \frac{\text{Primary Energy}_{\text{Actual Building}}}{\text{Primary Energy}_{\text{Reference Building}}} \quad [\text{i}]$$

$$CPC = \frac{\text{CO}_2 \text{ Emissions}_{\text{Actual Building}}}{\text{CO}_2 \text{ Emissions}_{\text{Reference Building}}} \quad [\text{ii}]$$

To comply with the NZEB specification an EPC of 1.0 and a CPC of 1.15 need to be achieved.

4. Use the Excel tool provided by the SEAI to define the renewable energy contribution. This will depend on the EPC and CPC achieved:
EPC 1.0 & CPC 1.15 → RER 20%
EPC 0.9 & CPC 1.04 → RER 10%

The performance of the reference building is defined in Appendix C of the Draft Part L Regulations as well as Appendix 1 of the Draft Interim Public Sector NZEB Performance Specification. Compared to the current 2008 Part L regulations, the performance of the reference building has improved, including:

- Improved building fabric performance;
- Increase mechanical equipment efficiencies;
- Increase lighting efficiencies and added occupancy and daylight control.

Changes between Part L 2008 and the new Part L/NZEB regulations are reflected by the increased performance of the reference building. The overall efficiency of the reference building increased by circa 50% to 60%.

3. Benchmark Office Building

The sample project used for this analysis is a 16,000m² office building, located in Dublin city centre. The building was designed to meet the Part L – 2008 regulations, achieving an EPC of 0.36 and a CPC of 0.36 under the 2008 Part L simulation. The efficiencies used were mainly driven by the requirement to achieve a Building Energy Rating of A3, which was part of the client brief. Less efficient systems could have been used to achieve Part L – 2008 compliance.

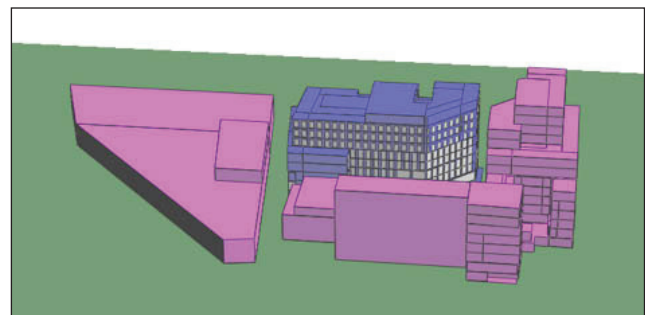


Figure 1 – Building simulation model image.

3.1 Building Fabric

Table 1: Building Fabric Values			
Construction Element	Part L 2008 reference values Appendix C	Design U-Values (to meet BER A3 rating)	g-value
Wall	0.27 W/m ² K	0.20 W/m ² K	
Glazing (Glass and Frame)	2.2 W/m ² K	1.20 W/m ² K	0.25
Roof	0.22 W/m ² K	0.16 W/m ² K	
Ground/ Exposed Floor	0.25 W/m ² K	0.20 W/m ² K	

An air permeability of 3 m³/m²/h @50Pa was assigned to the model.

Thermal bridging values as per Part L 2008 Table D2 were applied to the model^[7].

3.2 Mechanical System Efficiencies

The current specification for the building is fully air conditioned, using a 4-pipe fan coil unit system. Gas-fired boilers will produce heating while water-cooled chillers, in conjunction with hybrid dry coolers, will provide cooling. The systems were set up with the following efficiencies:

- Gas-fired boiler, 92% efficiency;
- Water cooled chiller, SEER 6.49 and EER 5.0;
- Specific fan power 1.5 W/l/s;
- AHU heat recovery 73% (thermal wheel);
- Optimal heating system controls
- Dedicated hot water boiler 90% efficiency;
- Hot water secondary circulation losses <10 W/m, 0.15kW pump power.

These system efficiencies are based on the design for Part L 2008 compliance and do not take NZEB requirements into account.

3.3 Lighting

The lighting was set to 8W/m² at 500 lux. Occupancy sensing was allowed for the whole building and daylight control was added to the perimeter zones.

4. Changes required to meet new EPC and CPC

The NZEB simulation was set-up as described in section 2.1. The iSBEM software program simulates the energy use for each end-use as illustrated in Table 2 and multiplies these with the relevant primary energy and carbon emission factor to calculate the annual primary energy use and the carbon emission.

Table 2: Actual and Reference Building Energy Uses results iSBEM

Energy Use	Actual Building [kWh/m ² /year] (Reflecting building design)	Reference Building [kWh/m ² /year] (Reflecting NZEB minimum requirements)
Heating Energy	17.66	25.31
Cooling Energy	8.51	20.02
Auxiliary Energy	19.82	11.51
Lighting Energy	21.13	45.49
Hot Water Energy	4.26	4.22

The primary energy and carbon emission factors are illustrated in Table 3. These factors are set by the SEAI.

The primary energy consumption for the reference building is calculated by multiplying the energy consumption of the reference building by the applicable primary energy factor, adding the results. Twenty per cent (20%) of the energy consumption of the reference building will be provided by renewable energies and will therefore be subtracted. The primary energy consumption for the actual building is calculated by multiplying the energy consumption of the designed building by the applicable primary energy factor, adding the results.

Table 3: Primary Energy and Carbon Emission Factors

Fuel	Primary Energy Factor	Carbon Emission Factor
Natural Gas	1.1	0.203
Electricity	2.19	0.473

$$\begin{aligned} \text{Primary Energy}_{\text{Actual Building}} &= (17.66 + 4.26) \cdot 1.1 + (8.51 + 19.81 + 21.13) \cdot 2.19 \quad [\text{i}] \\ &= 132.41 \text{ kWh/m}^2/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Primary Energy}_{\text{Reference Building}} &= ((25.31 + 4.22) \cdot 1.1 + (20.02 + 11.51 + 45.49) \cdot 2.19) - 40.24 = 160.92 \text{ kWh/m}^2/\text{year} \quad [\text{ii}] \end{aligned}$$

With the primary energy uses, the EPC can be calculated using the formula [i]. The CPC is calculated with formula [ii].

$$\text{EPC} = \frac{132.41 \text{ kWh/m}^2/\text{year}}{160.92 \text{ kWh/m}^2/\text{year}} = 0.82$$

$$\text{CPC} = \frac{33.76 \text{ kgCO}_2/\text{m}^2/\text{year}}{33.74 \text{ kgCO}_2/\text{m}^2/\text{year}} = 0.83$$

The EPC limit for compliance with the new Part L/NZEB regulations is 1.0 and the CPC limit is 1.15. The office building therefore meets the new EPC and CPC requirements without changing the initial design strategy developed to meet Building Regulations Part L 2008, and achieves a Building Energy Rating of A3. This design strategy represents current design standard for Dublin office buildings.

5. Changes required to meet RER

The initial design for compliance with Part L 2008 and achieving a BER A3 rating did not include any renewable energies. Under the new Part L/NZEB requirements, the building needs to meet a renewable energy ratio (RER) of 10%, as the EPC <0.9 and the CPC <1.04. Results based on a 20% RER requirement have been included for information. This section of the report analyses the opportunities for each renewable energy system allowed by the SEAI and reviews the practicability of introducing these renewable energies to the building for 10% and 20% RER.

The compliant renewable technologies are as follows:

- Photovoltaic;
- Solar panel – thermal;
- Wind energy;
- CHP;
- Biogas CHP;
- Biomass boiler;
- Heat pumps.

5.1 Photovoltaic (PV)

5.1.1 Requirements to meet RER

To calculate the RER when using PV, the following formula is applicable.

$$RER = \frac{\text{Primary Energy from renewable source}}{\text{Total Primary Energy}_{\text{Actual Building}}} \quad [\text{iii}]$$

To find out the amount of primary energy that needs to be provided by PV, the total primary energy consumption can be multiplied by the RER.

$$\text{Primary Energy PV} = 20\% \cdot \text{Total Primary Energy}_{\text{Actual Building}} \quad [\text{iv}]$$

$$\text{Primary Energy PV} = 20\% \cdot 132.42 \text{ kWh/m}^2/\text{year} = 26.48 \text{ kWh/m}^2/\text{year}$$

For the 10% renewable energy option, the primary energy is calculated as follows:

$$\text{Primary Energy PV} = 10\% \cdot \text{Total Primary Energy}_{\text{Actual Building}} \quad [\text{v}]$$

$$\text{Primary Energy PV} = 10\% \cdot 132.42 \text{ kWh/m}^2/\text{year} = 13.24 \text{ kWh/m}^2/\text{year}$$

Dividing the primary energy from PV through the primary energy factor for electricity will show the energy that needs to be provided by the PV system.

$$\text{Energy from PV} = \frac{\text{Primary Energy}}{\text{Primary Energy Factor Electricity}} \quad [\text{vi}]$$

$$\begin{aligned} \text{Energy from PV (to provide 20\% RER)} &= \frac{26.48 \text{ kWh/m}^2/\text{year}}{2.19} \\ &= 12.09 \text{ kWh/m}^2/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Energy from PV (to provide 10\% RER)} &= \frac{13.24 \text{ kWh/m}^2/\text{year}}{2.19} \\ &= 6.05 \text{ kWh/m}^2/\text{year} \end{aligned}$$

This calculation shows the amount of energy that needs to be generated by on-site PV to achieve the RER. The renewable energy contribution from PV has to be simulated using the iSBEM software. In the software program, it is possible to input area of PV, the PV type and orientation of the panels. The input is limited to four panels with a maximum of 1,000m² each.

Three PV types can be selected – Monocrystalline Silicone, Polychristalline Silicone and Amorphous Silicone. The simulation assumes a different efficiency factor for each of these PV types as shown in Table 4^[8].

The simulation was set-up with the PV area orientating south at a 30° angle with all three PV types available. The simulation results are shown in Table 4.

The results shown in Table 4 illustrate that 3,200m² of south-facing Monocrystalline or 4,000m² Polychristalline PV at a 30° angle is required to meet an RER of 20%. A RER of 10% can be achieved with 1,600m² of PV.

5.1.2 Feasibility

The office block is a 10-storey, high-rise building with a total roof area of 1,908m². The public realm area around the building is not feasible for PV as this area is shaded by adjacent high-rise buildings. A feasible area of 1,600m² PV could be placed on the roof. This would take most of the roof area and would not leave any space for rooftop terraces or a green roof. This area would provide 10% of the RER.

There is the possibility to reduce the overall energy consumption of the building to reduce the requirements on PV. The overall energy consumption of the building would need to be reduced to 1/3 of the current consumption to make a PV solution feasible.

Table 4: PV

PV Array Type	PV Area [m ²]	PV Efficiency	Primary Energy [kWh/m ² /year]	RER	Meets RER 20% ?	Meets RER 10% ?
Monocrystalline Silicone	3,200	15%	12.94	21%	Yes	Yes
Monocrystalline Silicone	1,600	15%	6.47	10%	No	Yes
Polychristalline Silicone	4,000	12%	12.94	21%	Yes	Yes
Amorphous Silicone	4,000	6%	6.47	11%	No	Yes
Other thin films	4,000	8%	8.63	14%	No	Yes

The simulation was run changing the building from an air conditioned office building to natural ventilation, to analyse the effect on RER requirements when cooling energy is excluded. With the change, the actual building energy consumption dropped from 132.42 kWh/m²/year to 98.38 kWh/m²/year using formula (iv) and (v) to calculate the primary energy contribution required by PV.

$$\text{Primary Energy PV} = 10\% \cdot 98.38 \text{ kWh/m}^2/\text{year} = 9.8 \text{ kWh/m}^2/\text{year}$$

$$\text{Energy from PV} = \frac{19.68 \text{ kWh/m}^2/\text{year}}{2.19} = 4.5 \text{ kWh/m}^2/\text{year}$$

For a naturally-ventilated building, 25% less PV area will be required to meet the renewable energy ratio. Using the most efficient Monocrystalline Silicone type of PV, 1,280m² of south-facing PV would be needed. This area could be accommodated with the roof area available, but would cover a large extent of the roof area.

5. Solar Panel – Thermal

5.2.1 Requirements to meet the RER

The simulation software limits the area of solar thermal panels to 400m². This area delivers 12.98 MJ/m². The primary energy from solar panels is calculated by the fuel that would otherwise be used by the hot water generator and takes the heating efficiency and primary energy factor of this system into account. Gas fired hot water generation, originally selected for the building with 91% efficiency, was used with a primary energy factor of 1.1.

$$\text{Primary Energy Solar} = \frac{\text{Energy by Solar Panel}}{\text{Boiler Efficiency}} \cdot \text{Prim. Energy Factor Elec.} \quad [\text{vii}]$$

$$\text{Primary Energy Solar Panels} = \frac{12.98 \text{ MJ/m}^2}{3.6 \cdot 0.91} \cdot 2.19 = 8.68 \text{ kWh/m}^2/\text{year}$$

5.2.2 Feasibility

A RER of 20% or 10% cannot be met with solar panels for this project. Only 5% RER is achieved. Solar panels are not a feasible option to meet the RER as a stand-alone solution.

5.3 Wind Energy

5.3.1 Requirements to meet RER

The same amount of energy as calculated under 5.1.1 needs to be generated by wind energy to cover the RER. The wind turbine needs to generate 12.09 kWh/m²/year to meet the RER. Based on the building size, this is a total of 193,440kWh per year. Based on manufacturers' information, a free-standing, large-scale, wind turbine with 22m rotor diameter can produce 209,153 kWh per year at an average wind speed of 6m/s^[9].

The NEAP procedure does not allow manufacturers' data to be used. The wind turbine output needs to be simulated using iSBEM. This should ensure conformance between projects.

The simulation program was used to simulate a large-scale wind turbine, using the manufacturer. The turbine is set up with the following parameters:

- Terrain type is urban with average building height >15m. (This applies a terrain factor of 0.24 which reduces the power calculated by the software accordingly. In addition, a roughness length of 1 is used to calculate a roughness coefficient depending on the hub height. For the urban terrain type, the factor is 1);
- Hub height 30m;
- Rated power 60kW;
- Horizontal Axis 22m.

The simulation results show an annual energy production of 2.32 kWh/m²/year from the wind turbine. This covers 4% of the annual energy consumption and does not achieve the 10% or 20% RER. The simulation shows that the stated output by the manufacturer is different to the simulation results. This is due to the manufacturer's data being referred to measurements in an unobstructed area, whereas the simulation takes the urban area into account.

A small-scale roof-mounted wind turbine was not simulated as the requirements cannot be met using a large-scale wind turbine.

5.3.2 Feasibility

Due to the city centre location, a large-scale wind turbine cannot be practically incorporated into the project. A roof-mounted wind turbine would be more applicable to this project, but would only provide a fraction of the energy that a large-scale turbine would provide. The performance of roof-mounted wind turbines in urban locations is reduced compared to a free-standing turbine, as buildings obstruct air flows and create turbulence. In addition, wind turbines mounted on buildings create structural vibration and noise implications.

5.4 CHP

The CHP was set-up using a sample selection to provide the full heating and hot water load to the project. A thermal seasonal efficiency of 58% and a heat to power ratio of 1.8 was used. Based on this data, the simulation results show a CHP usage for heating and hot water of 31.93 kWh/m²/year.

The renewable primary energy supplied by the CHP is based on the heating and hot water provided by the CHP, multiplied by the ratios of the primary energy factors and the electrical and thermal efficiencies.

$$RPE_{CHP} = Q_{Gas_{CHP}} \cdot E_T \cdot \left(\frac{PEF_{Gas}}{E_B} + Elec\ Eff\ CHP \cdot \frac{PEF_{Elec}}{E_T} - \frac{PEF_{Gas}}{E_T} \right) \quad [viii]$$

$$Renewable\ Primary\ Energy\ CHP = 31.93 \frac{kWh}{m^2} \cdot \left(\frac{1.1}{0.86} + 32\% \cdot \frac{2.19}{58\%} - \frac{1.1}{58\%} \right) = 10.94 \frac{kWh}{m^2}$$

$$RPE_{CHP} = Renewable\ Primary\ Energy\ CHP$$

$$Q_{Gas_{CHP}} = Gas\ Consumption\ CHP$$

$$E_T = Thermal\ Efficiency\ CHP$$

$$PEF_{Gas} = Primary\ Energy\ Factor\ Gas$$

$$PEF_{Elec} = Primary\ Energy\ Factor\ Electricity$$

$$E_B = Minimum\ Boiler\ Efficiency$$

Based on the efficiencies used, the renewable primary energy provided is 10.94 kWh/m²/year which leads to an 8% RER.

5.4.1 Feasibility

CHP requires predictable and constant loads for optimal performance and will be more cost-efficient when operating continuously. Fluctuating thermal loads will either require a reduction in the power generation by the CHP or the rejection of waste heat which reduces the overall CHP efficiency^[10]. For an office block the hot water generation would provide a constant load throughout the year. Heating will not be required during summer. The hot water load alone is small compared to the overall energy consumption and only achieves a RER of 1%. Even a full load CHP only provides 8% of the RER and is not a feasible option for this project.

5.5 Biogas CHP

Compared to the CHP calculation in Section 5.4, the primary energy provided by the biogas CHP is higher, as the fuel used for the CHP is considered renewable. The primary energy factor is calculated as follows:

$$Renewable\ Primary\ Energy\ CHP = Heating \cdot \left(\frac{PEF_{Gas}}{Boiler\ Eff} + Elec\ Eff\ CHP \cdot \frac{PEF_{Elec}}{Thermal\ Eff\ CHP} \right) \quad [ix]$$

$$Renewable\ Primary\ Energy\ CHP = 18.52 \frac{kWh}{m^2} \cdot \left(\frac{1.1}{0.86} + 32\% \cdot \frac{2.19}{58\%} \right) = 46.06 \frac{kWh}{m^2}$$

The primary renewable energy provided by the biogas CHP provides an RER of 38% and exceeds the requirements by the NZEB regulations.

5.5.1 Feasibility

Biogas is not a feasible energy source for a city centre project. Requirements around the biogas storage cannot be reasonably incorporated into the planning scheme. In addition, biogas is not readily available in Ireland. Biogas is therefore not a feasible option for this building, even though the percentage of RER can be met. Biogas could become a more feasible option if the market adapts and can guarantee a piped biogas supply for city centre locations.

5.6 Biomass Boiler

The primary energy used by a biomass boiler is determined by multiplying the heating and hot water energy consumption by a primary energy factor of 1.1. The total primary energy consumption

for biomass is 24.13 kWh/m²/year. Comparing this to the overall primary energy consumption of the building using formula 3, only 18% RER can be achieved.

$$RER = \frac{24.12 \frac{kWh}{m^2 \text{ year}}}{132.42 \frac{kWh}{m^2 \text{ year}}} = 0.18$$

Similar to Section 5.2, a change to a naturally-ventilated building was analysed for the biomass boiler. For a naturally-ventilated building the cooling element was completely removed from the simulation. This change resulted in a reduction in total actual building energy usage and an increased proportion of heating load compared to the overall load. Using Formula 3, the biomass boiler option achieves 44% RER.

$$RER = \frac{42.83 \frac{kWh}{m^2 \text{ year}}}{98.37 \frac{kWh}{m^2 \text{ year}}} = 0.44$$

5.6.1 Feasibility

Providing renewable energy with biomass does meet the 10% RER, but falls short if 20% would be the target. Biomass is a renewable energy system purely based on the energy for heating and hot water. This load only accounts for 18% of the total building energy consumption when the building is air conditioned. A renewable energy solution for heating and hot water only will only achieve the RER as a single system if the RER target is 10%. For a 20% target, an additional 2% would need to be met by an alternative type of renewable energy, e.g. PV.

An area of 510m² of PV would be required to deliver 1.1 kWh/m²/year to provide the additional 2%.

Frequent deliveries and large storage areas required for biomass can often be a problem, particularly in the context of this city centre site. The RER can be met when the building air conditioning system is removed and the building will be fully naturally ventilated.

5.7 Heat Pumps

The system was changed in the iSBEM simulation to heat pump, using the efficiencies outlined in Table 5. Different types of heat pumps can be used, such as air to water heat pumps, ground source heat pumps or VRF systems. These efficiencies used are based on a VRF system selection by Mitsubishi Electric.

The energy use of the actual building (listed in Table 2) changes due to the change in system type. The actual building total primary energy consumption changes to 139.81 kWh/m²/year.

In the Excel tool the percentage of heating and hot water, and the efficiencies, need to be entered. These were set to 100% for both heating and hot water.

The values shown in Table 5 were used:

Table 5: Heat Pump		
	Heating	Hot Water
Percentage Supplied	100%	100%
Heat Pump Efficiency	350%	350%

The heat pump efficiency for heating and hot water needs to be above 219% to be counted as renewable energy. This is a minimum requirement set by the SEAI.

The following formula is used to calculate the primary energy provided by the heat pump for heating and hot water:

$$\left(350\% \cdot \frac{1.1}{0.86} - 219\%\right) \cdot 4.52 + \left(350\% \cdot \frac{1.1}{0.86} - 219\%\right) \cdot 1.13 = 12.91 \frac{kWh}{m^2 \text{ year}}$$

The heat pump renewable primary energy of 12.91 kWh/m²/year provides a renewable energy ratio of 9% which does not meet the RER.

5.7.1 Feasibility

A heat pump system would be feasible to install for a city centre office building, as there are no fuel delivery, storage or space challenges. A heat pump system on its own reaches 9% of the RER and would be just below meeting the RER target of 10%. To achieve the 10% or 20% RER target, this could be achieved in combination with a PV installation as outlined in Section 5.1.

5.8 Renewable Energy Results

Table 6 summarises the renewable energy options and the RER percentages achieved by each option for an air conditioned building.

Table 6: Renewable Energy Results			
Renewable Energy Solution	RER Air Conditioned Building	NZEB compliant for 20% RER?	NZEB compliant for 10% RER?
PV (full roof)	10%	No	Yes
Solar Thermal	5%	No	No
Wind Energy	4%	No	No
CHP (domestic hot water)	1%	No	No
CHP ((heating and domestic hot water)	8%	No	No
Biogas CHP	38%	Yes (not feasible)	Yes (not feasible)
Biomass	18%	No	Yes
Heat Pump	9%	No	No

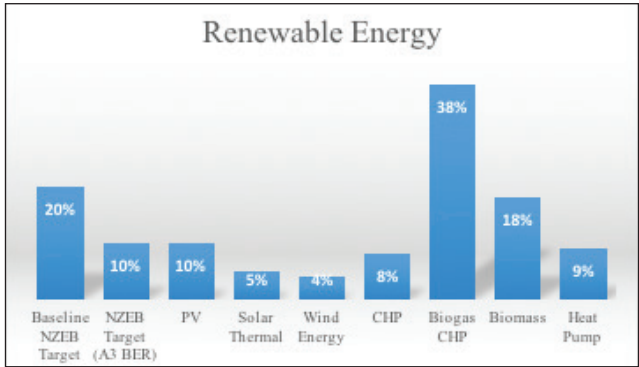


Figure 2 Renewable Energy Results.

To meet the 10% RER there are several options that can be considered – biomass or a heat pump in combination with PV.

None of the renewable energy solutions can meet the RER of 20% individually with the exception of biogas CHP. As discussed in Section 5.5, this would not be a feasible option for a city centre project. Therefore, a combination between a heating-based renewable energy system such as biomass, or a heat pump and a PV system (electricity based), would be required.

Table 7: Combination of Renewable Energy Solutions

Combination of Renewable Energy Solutions	Heating	NZEB 20% complaint?
Biomass	510m ² PV	Yes
Heat Pump	1,500m ² PV	Yes

6. Limitations

This section discusses the limitations of the new Part L/NZEB regulations and the iSBEM simulation tool.

6.1 Limitations of iSBEM

6.1.1 Simplicity

The initial purpose of the simulation tool was to provide a comparison tool between all buildings in Ireland for Building Energy Rating and compliance check with Part L. The tool was not intended for design purposes. With the new Part L/NZEB regulations, the simulation tool enhances the renewable energy contribution and with that drives design decisions and project investments. There would be an argument to introduce dynamic simulation instead of iSBEM to provide a more accurate prediction of the energy uses, and therefore a more accurate renewable energy contribution. Detailed simulation procedures and guidelines would need to be provided by the SEAI to make dynamic simulation feasible.

6.1.2 Project Typology

The tool purely focuses on heating, hot water, auxiliary, lighting and cooling and does not take any process energy into account. Considering renewable energy for example for a healthcare project or a production facility, the process loads would be a major driver for selecting renewable energy systems. This is not accounted for in the NZEB simulation.

6.2 Limitations of the NZEB Methodology

The renewable requirements of the new Part L/ NZEB methodology does not place any emphasis on the actual feasibility of the systems for different project types, nor the actual operation of the system. The introduction of a CHP in an office building for example, does not consider if any of the heat provided by the CHP will be used in the building. The tool leads to oversized CHPs whereas the usage would not be constant and heat would need to be dumped during periods. CHPs could be integrated to buildings for a “checkbox” exercise to

meet NZEB regulations but would not lead to an energy-efficient solution^[11]. A second example is PV. The simulation requires an area of PV but does not take overshadowing into account. PV arrays in shaded areas could be installed to meet the regulations, but this would not provide an efficient solution for the building.

7. Impact of new Part L/ NZEB regulations on current design process

The new Part L regulations will significantly impact the current design process in terms of capital costs, space and planning considerations. The analysis shows that the initial design methodology used for this office building does not meet the new regulations and changes need to be introduced.

Particular emphasis will be placed on the integration of renewable energy, finding the optimal solution between renewable energy systems to find the cost optimum solution for the client. This will influence the system selection typically used in offices in Dublin which is gas-fired boilers in combination with a chiller and FCUs.

The renewable energy options that were shown to be feasible to meet the new Part L/NZEB regulations are heating-based solutions (heat pump or biomass boiler) when a 10% RER is required. If a 20% RER is needed, these solutions would only be feasible in combination with PV (heat pump and PV or biomass boiler and PV). Purely electrically-based solutions such as PV or wind energy are not feasible on their own. Purely heating and hot water based solutions are only feasible for the 10% RER target, as the heating and hot water load showed to be less than 20% of the overall energy consumption for the sample project analysed.

The building design will be pushed to provide a more energy-efficient building solution to target the 10% RER and reduce the amount and size of renewable energies. This will influence architectural and building envelope design. More emphasis will be based on a holistic design approach between all design teams to find the cost-optimum solution for the client. It is envisaged that project teams will need to provide detailed cost analysis between renewable energy systems and building envelope improvements to arrive at the most feasible and cost-optimum solution for the client.

An alternative way of compliance is the shift from air conditioned buildings to naturally-ventilated buildings. This is currently not a market option for a high-profile Dublin office building but could be a low-budget solution to meet the new Part L/ NZEB regulations. A market shift to naturally-ventilated buildings could be caused by the new regulations.

8. Conclusions

The report reviewed the new Part L regulations that are introducing a requirement for Nearly Zero Energy Buildings (NZEB), and the effect on a city centre office building design. NZEB introduces an increased requirement for building envelope and system efficiencies

and presents a minimum renewable energy contribution.

The report highlights that the increased requirements for building envelope performance and system efficiencies can be met with a building designed to meet a Building Energy Rating of A3, which represents current design standard for Dublin office buildings.

On the other hand, the renewable energy contribution for an air conditioned office building depends on the overall building efficiency. Buildings that just meet the new Part L energy efficiency requirements need to provide 20% renewable energy. This can only be achieved using a combination of a heating/domestic hot water based solution, as well as an electricity-based renewable energy system. The most feasible options are a biomass boiler in combination with PV, or a heat pump system in combination with a large area of PV. For projects that exceed the new overall energy and carbon requirements, a 10% renewable energy contribution applies. Technically feasible solutions are biomass, heat pumps or PV.

It is expected that more emphasis will be placed on a holistic design approach between the design teams to reduce the overall energy consumption to reduce the amount of renewable energy required. Cost analyses will be needed to review the cost-optimum solution. The regulations could also cause a market shift from air conditioned to naturally-ventilated buildings, as this reduces the amount of renewable energy needed. This would provide a low-cost option for compliance, but suitability of natural ventilation and the impacts on design aspects such as internal temperatures, façade design and thermal comfort could provide complications that need to be assessed on a project by project base.

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